Physics 106b-2011 Class 24 Wednesday 3-30-11 Summary

Faraday's law

$\vec{E} = E(x,t)\,\hat{y}$

$\vec{B} = B(x,t)\,\hat{z}$

Book pp. 890-1 $\longrightarrow$ $$\frac{\partial E}{\partial x} = -\frac{\partial B}{\partial t} \quad (1)$$

Ampère's Law in vacuum

$\vec{E} = E(x,t)\,\hat{y}$

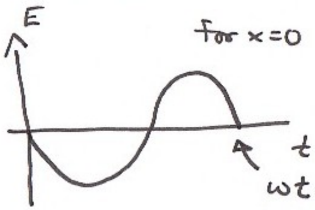
$\vec{B} = B(x,t)\,\hat{z}$

Book pp. 890-1 $\longrightarrow$ $$\frac{\partial B}{\partial x} = -\mu_0 \varepsilon_0 \frac{\partial E}{\partial t} \quad (2)$$

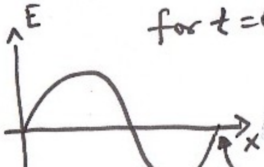
our guess, a "sinusoidal plane wave":

* $$\vec{E} = E_p \sin(kx - \omega t)\,\hat{y}$$ $$\vec{B} = B_p \sin(kx - \omega t)\,\hat{z}$$ *

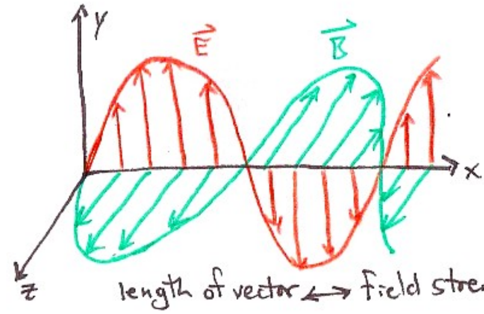
A reminder of what this represents:



$\omega t = 2\pi$, $t = \text{period} = T$ $\rightarrow$ ** MEM: $\omega = \frac{2\pi}{T}$ ← "angular frequency" ** MEM



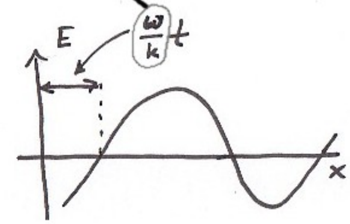
$kx = 2\pi$, $x = \lambda$ $\rightarrow$ ** MEM: $k = \frac{2\pi}{\lambda}$ ← "wavenumber" ** MEM



length of vector ↔ field strength

$$E_p \sin(kx - \omega t) = E_p \sin\left[k\left(x - \frac{\omega}{k}t\right)\right]$$

** MEM: **"phase velocity" $v_p \equiv \frac{\omega}{k}$**



→ satisfies (1) if $kE_p = \omega B_p$ (A)

→ satisfies (2) if $kB_p = \mu_0 \varepsilon_0 \omega E_p$ (B)

→ In vacuum, Ampère's Law & Faraday's Law predict a self-sustaining wave of perpendicular $\vec{E}$ & $\vec{B}$ fields. The changing $\vec{B}$ creates a changing $\vec{E}$ which creates the changing $\vec{B}$, etc. To be consistent w/ MEQ's,

** $$\text{speed} = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} \equiv c$$

$E = cB$ ($\vec{E}$ & $\vec{B}$ waves are in phase) **